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F00 BIT OPTIMIZATION PROJECT

Meeting Schedule

Date: 5/22/98 Time: 1.30 PM Venue: Conference Room, E 159B

Agenda

1. Introduction by S.J. Huang.
2. IDEAS program validation and development.
3. Analysis of current F00 bit design.
4. Benchmarking of F00 bit with respect to F05 and FDS bits. ✓
5. Development of F00 bit design.
 - Preliminary Insert Designs and their comparative analysis. ✓
 - Variation of Insert counts and consequent results. ✓
 - Modification of bit cutting structure with results.
 - Discussion of results followed by recommendations for future development.

1 ☐ **F00 BIT OPTIMIZATION PROJECT**
SMITH INTERNATIONAL, INC.

2 ☐ **Agenda**

- IDEAS PROGRAM VALIDATION AND DEVELOPMENT
- ANALYSIS AND BENCHMARKING OF CURRENT F00 BIT DESIGN WITH RESPECT TO F05 AND FDS BITS
- DEVELOPMENT OF THE F00 BIT
- NEXT STEP
- REAL TIME CHALLENGES
- SUPPLEMENTARY WORK

3 ☐ **Program validation and development**

- Duplicating field results
 - W.O.B.= 7-13 kdAN
 - R.P.M.=80-240 rpm
 - R.O.P.=35 m/hr
- IDEAS Parameters & Results
 - Rock Types
 - Ductile
 - Brittle
 - W.O.B.=10,000 kg-f
 - R.P.M.=140 rpm
 - R.O.P.=24-28 m/hr
- Verifying performance trends

4 ☐ **Analysis and Benchmarking of current F00 bit design**

- Identifying Key Performance Parameters
 - R.O.P.
 - Coverage
- Comparison with FDS and F05 bit designs

5 ☐ **The Target**

- DUCTILE ROCK
 - R.O.P.=24.82 m/hr
 - COVERAGE=56.02 %
- BRITTLE ROCK
 - R.O.P.=26.95 m/hr
 - COVERAGE=39.59 %

6 ☐ Development of F00 bit design

- Insert shapes
 - 10 different shapes compared
- Row counts
 - Adding and subtracting Inserts from all rows
- Cutting structure modifications
 - Improving core design

7 ☐ Selection of Inserts

- CONVENTIONAL DESIGNS
 - CHISEL
 - VECTOR
 - CONICAL
- EXPERIMENTAL DESIGNS
 - MAVERICK
 - DURA
 - COBRA

8 ☐ Surpassing The Target in Ductile Rock

- INSERT SHAPES
 - R.O.P. = 12% Increase [Vector]
 - COVERAGE = 4% Increase [Vector]
- ROW COUNTS
 - R.O.P. = 16% Increase [-1 Insert on each row]
 - COVERAGE = 5% Increase [-1 Insert on each row]

9 ☐ Achieving The Goal in Brittle Rock

- INSERT SHAPES
 - R.O.P. = 62% Increase [Vector] (Coverage being 5% lower)
 - COVERAGE = 5% Increase [Concept] (R.O.P. being 9% lower)
- ROW COUNTS
 - R.O.P. = 15% Increase [+1 Insert on each row]
 - COVERAGE = 14% Increase [+2 Inserts on each row]

10 ☐ Next Step

- Combination/selection of optimized insert shape for drive rows
- Optimize cutting structure
 - Bottom hole profile
 - Individual Row counts
 - Skip pitches

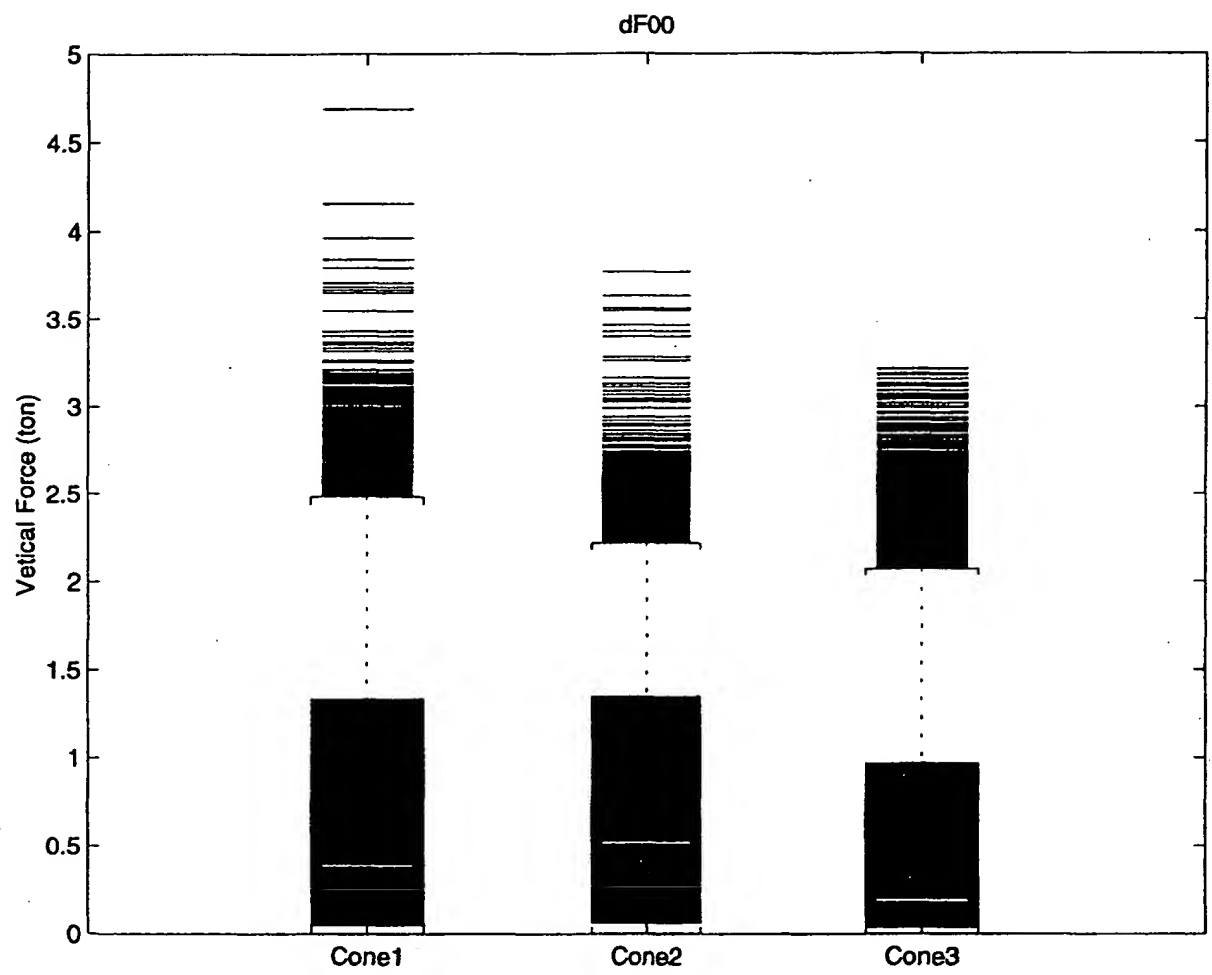
- Force Analysis
 - Balancing cutting structure based on forces
- Study of gage area

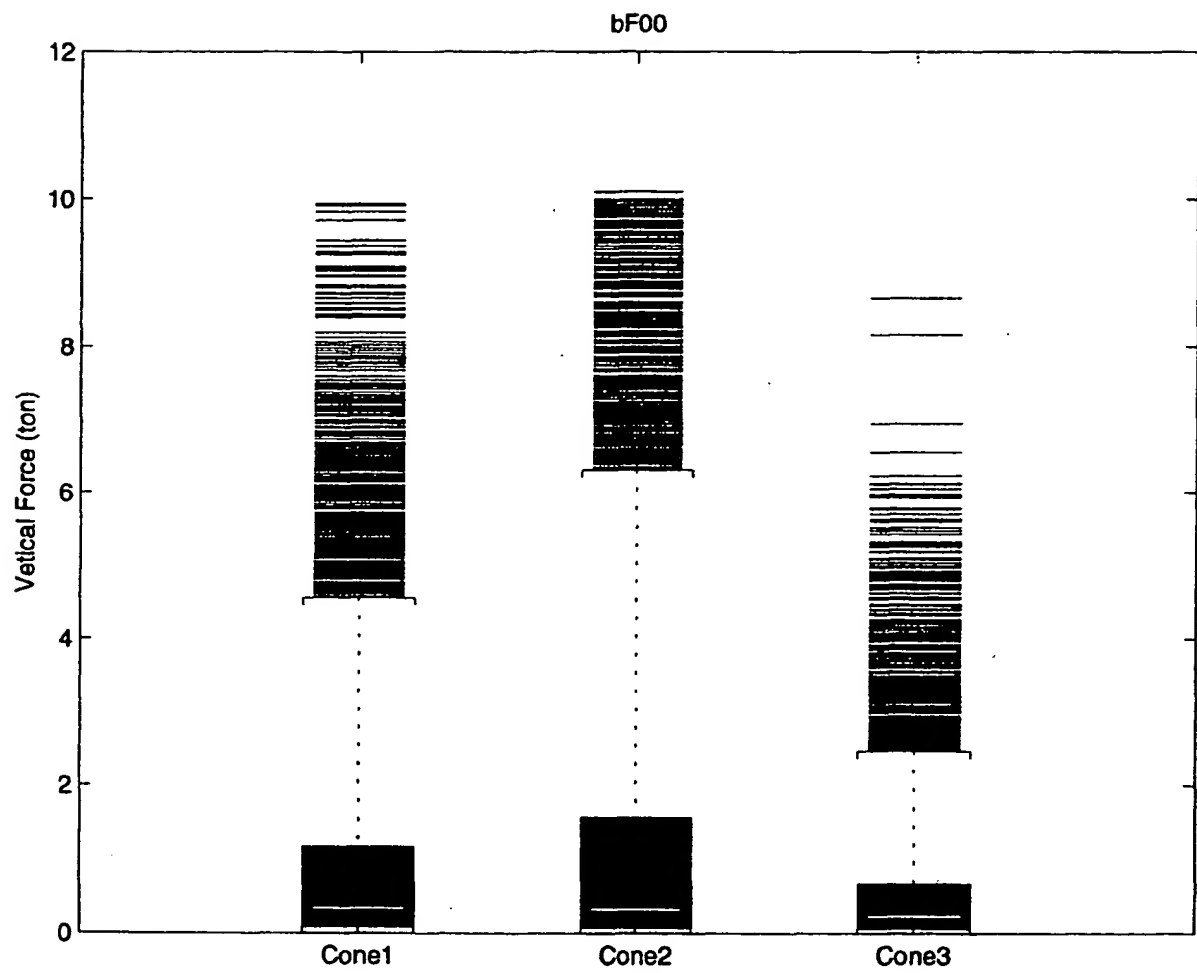
11 ☐ Real Time Challenges

- Insert Retention
 - Iceman
 - Trucut
- Insert Rotation
 - Iceman
 - Off-gage
- Insert Breakage
 - Iceman
 - Off-gage
 - Trucut
- Cone Peeling

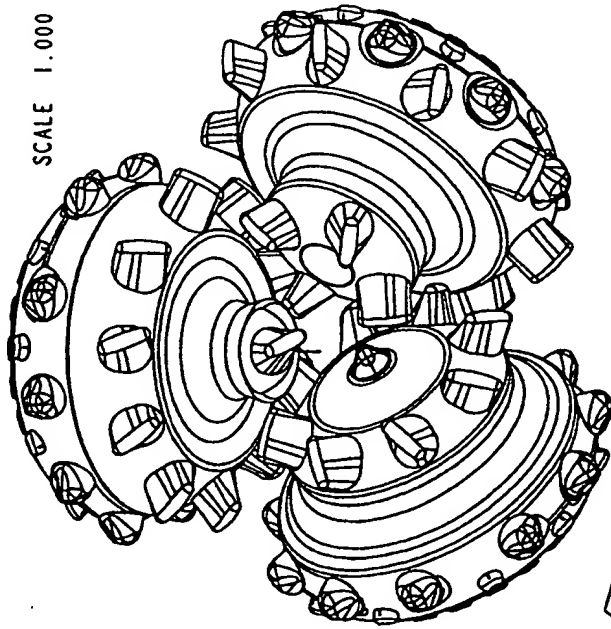
12 ☐ Supplementary Work

- IDEAS program development
- Lab testing
 - Single insert indentation tests
- Insert manufacture (Including RTW in the design loop)
 - Injection Molding
 - Punch and die process
- Patent Issues

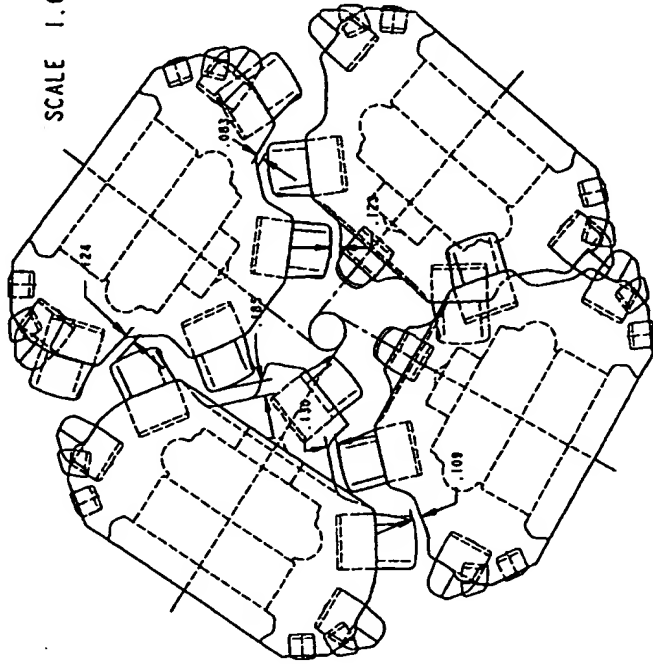




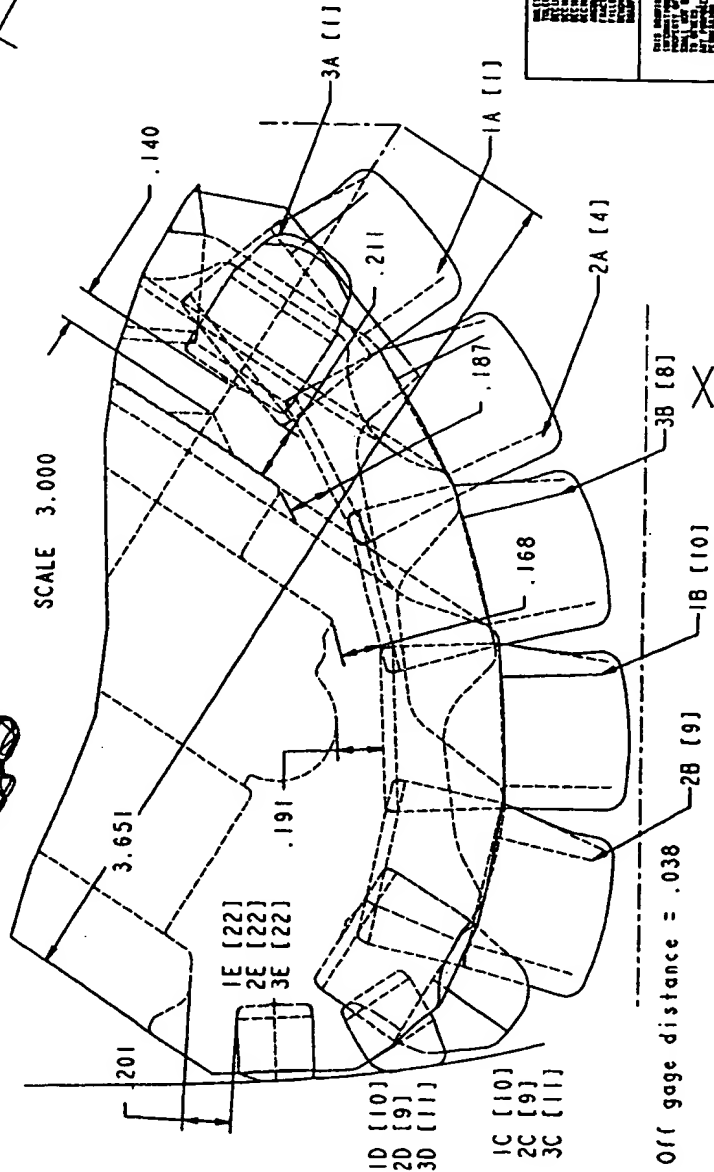
SCALE 1.000



SCALE 1.000



SCALE 3.000



NAME	ROW	INSERT	COUNT	PITCH	TYPE	DIAMETER	LENGTH	EXT	GRIP	GRADE
CORE1	A	ORCA3	1	-	ORCA	.3175	.475	.310	.350	514
	B	ORCA3	10	10.42	ORCA	.3175	.475	.310	.350	514
	C	R. GAGE	10	10.42	R. GAGE	.3175	.475	.310	.350	514
	D	0018124	10	10.42	31C	.3175	.475	.310	.350	514
	E	0018134	22	-	31C	.3175	.475	.310	.350	514
CORE2	A	ORCA1	1	-	ORCA	.3175	.475	.310	.350	514
	B	ORCA1	10	10.42	ORCA	.3175	.475	.310	.350	514
	C	R. GAGE	10	10.42	R. GAGE	.3175	.475	.310	.350	514
	D	0018124	10	10.42	31C	.3175	.475	.310	.350	514
	E	0018134	22	-	31C	.3175	.475	.310	.350	514
CORE3	A	0010322	1	-	ORCA	.3175	.475	.310	.350	514
	B	ORCA1	10	10.42	ORCA	.3175	.475	.310	.350	514
	C	R. GAGE	10	10.42	R. GAGE	.3175	.475	.310	.350	514
	D	0018124	10	10.42	31C	.3175	.475	.310	.350	514
	E	0018134	22	-	31C	.3175	.475	.310	.350	514

PART NUMBER: LT077-ORCA

SMITH TOOL

Division of Smith International Inc.

077 F00 BIT LAYOUT
ORCA INSERTS

SCALE: 0.1	MODEL NAME: LT077-ORCA	SHEET: 1 OF 1
DATE	DRAWING NO.	REV
C	AS	4-Jun-98
		DLT077-ORCA

Off gage distance = .038

IDEAS Calculation Summary

Project: /users/fa8297/ideas/orca-bit
Diameter of Bit: 7.87 (in) [200 (mm)]
Weight on Bit: 22046 (lbf) [10000 (kgf)]
Revolutions per minute: 140 (rpm)
Revolutions of Simulated: 40 (rev)
Hardness coefficient of Rock: 14504 (lbf/in2) [100.0 (Mpa)]
The Critical Contact Depth of Rock: 7.874 [in] [200.0 (mm)]
Anti-breakage Factor of Rock: 1000.000 (Mpa/mm)
Borehole area: 48.707 (sq.in)

Rev. CutArea Coverage
(sq.in) %

1	20.94	43.00
2	27.54	56.53
3	26.24	53.88
4	25.16	51.66
5	26.82	55.06
6	31.18	64.02
7	26.00	53.39
8	27.28	56.01
9	30.34	62.30
10	28.54	58.60
11	26.23	53.86
12	25.48	52.31
13	27.01	55.45
14	31.35	64.36
15	22.71	46.62
16	28.75	59.03
17	26.37	54.15
18	28.02	57.53
19	28.74	59.00
20	30.89	63.42
21	26.36	54.13
22	26.43	54.26
23	29.97	61.52
24	24.78	50.88
25	28.05	57.58
26	29.69	60.96
27	23.68	48.63
28	26.64	54.69
29	30.10	61.79
30	22.58	46.36
31	28.48	58.47
32	26.57	54.55
33	27.83	57.13
34	24.03	49.34
35	32.74	67.22
36	29.79	61.16
37	24.48	50.26
38	26.74	54.90
39	27.40	56.25
40	26.16	53.71

Average of Coverage for Bit: 55.85 %

Average of Coverage for Each Row:

Cone	Row	Rmin (in)	Rmax (in)	C.Avr (sq.in)	CovI %	CovA %
1	1	3.827	3.937	0.005	0.17	0.01
1	2	3.488	3.937	0.488	4.66	1.00
1	3	3.047	3.936	1.986	10.19	4.08
1	4	1.898	3.074	6.412	34.92	13.17
1	5	-0.020	1.007	0.460	14.46	0.95
2	1	3.802	3.937	0.005	0.14	0.01
2	2	3.507	3.937	0.341	3.39	0.70
2	3	3.013	3.936	1.680	8.34	3.45
2	4	2.544	3.768	6.231	25.67	12.79
2	5	0.537	1.651	2.506	32.75	5.15

3	1	3.807	3.937	0.005	0.15	0.01
3	2	3.486	3.937	0.465	4.42	0.95
3	3	3.008	3.937	2.215	10.92	4.55
3	4	1.225	2.351	4.360	34.47	8.95
3	5	0.352	0.738	0.029	2.23	0.06

Max Penetration Depth 0.437 (ft) [133 (mm)]

Average of ROP 85.38 (ft/h) [26.02 (m/h)]

Ratio of Cone Rotary Speed to Bit:

Cone	Ratio
1	1.1950
2	1.2750
3	1.1320

Scraping Brittle File Size 19248 (bytes)

Vertical Brittle File Size 19200 (bytes)

Shell Contacted Times 255 (times)

Contact Percentage of Shell to Rock 5.3125 %

~~Cone 1~~

F_r

F_c

F_z

Cone 1

2.5/2.6 .7

3.6/3.7

Cone 2

3.0/3.1 .7

4.2/4.5

Cone 3

2.0/1.7 .3

2.6/2.5

Cone 1 Blow

1.8/1.6 .2

2.7/2.5

Cone 3 Blow

1.6/1.6 .2

2.0/2.2